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Birthdate: July 25, 1956 (Pittsburgh, Pennsylvania)
 Married to Andrew Lange, 3 sons (James, b. 1990; William, b. 1995; Joseph, b. 1997)

Employment

2000- Dick and Barbara Dickinson Professor of Chemical Engineering and Biochemistry
 1999-2000 Professor of Chemical Engineering and Biochemistry
 1996-1999 Professor of Chemical Engineering
 1992-1996 Associate Professor of Chemical Engineering
 1987-1992 Assistant Professor of Chemical Engineering, California Institute of Technology
 1986-1987 Visiting Associate, Chemistry, California Institute of Technology
 1985-1986 Research Fellow, Department of Chemistry, University of California, Berkeley
 1979-1980 Research Engineer, Solar Energy Research Institute, Golden, Colorado

Honors and Awards

2005 Berkeley Lectures in Chemical Engineering, U.C. Berkeley
 2005 Garvin-Olin Medal, American Chemical Society
 2005 Food, Pharmaceuticals, and Bioengineering Division Award, AIChE
 2004 Institute of Medicine of the National Academies
 2004 Royal Society Rosalind Franklin Lecturer, Cambridge, UK. Chemistry
 2003 Sir Robert Price Lecturer, CSIRO, Melbourne
 2003 Carothers Award, American Chemical Society Delaware Division
 2003 David Perlman Lecture Award, American Chemical Society, Biochemical Technology
 2003 Lindsay Distinguished Lecturer, Texas A&M, Chemical Engineering
 2003 Merck-Frosst Invited Lecturer, Biochemistry, U. Alberta
 2001 Texas Distinguished Lecturer, U. T. Austin, Chemical Engineering
 2001 Fellow, American Institute for Medical and Biological Engineering
 2000 National Academy of Engineering
 2000 Professional Progress Award, American Institute of Chemical Engineers
 2000 Bayer Lecturer, Chemical Engineering, U. C. Berkeley
 1998 Science Innovation Topical Lecturer, 150th meeting of the AAAS, Philadelphia
 1998 Purves Lecturer in Chemistry, McGill University
 1996 William Rauscher Lecturer in Chemistry, Rensselaer Polytechnic Institute
 1995 Opening speaker, first "Frontiers of Engineering" Symposium, Nat. Acad. Engineering
 1995 American Institute of Chemical Engineers, Separations Division
 Graduate Research Paper Award (with V. Sundaresan)
 1995 1995 Speaker, "Chancellor's Lecture Series Honoring Distinguished Women
 Scholars," Department of Chemistry, University of Pittsburgh
 1994 Annual Lecturer, Advanced Centre for Biochemical Engineering, University College
 London
 1994 Van Ness Award Lecturer in Chemical Engineering, Rensselaer Polytechnic Institute
 1989 NSF Presidential Young Investigator Award
 1989 David and Lucile Packard Fellowship in Science and Engineering
 1989 Whitaker Foundation Investigator
 1988 Office of Naval Research Young Investigator Award (Molecular Biology)
 1979 Phi Beta Kappa, Tau Beta Pi

Education

1985 Ph.D., Chemical Engineering, University of California, Berkeley,
1979 B.S., *magna cum laude*, Mechanical and Aerospace Engineering,
Princeton University.

Professional Activities

Science Board, Santa Fe Institute, 1999-
AAAS Officer, Member-at-Large, Engineering Section 2005-
Science Advisory Board, Altus Biologics, 2003-2004
Science Advisory Board, Codexis, Inc., 2002
Science Advisory Board, Maxygen, Inc., 1997-2002
Science Advisory Board, Fluidigm Corporation, 1999-
Science Advisory Board (Biotechnology), Wella AG, 1999-2005
Science Advisory Board, Odyssey Thera, 2001-2003
Science Advisory Board, NuAce, Inc. 2002-
Advisory Board, International Society for Nanoscale Science, Computation, and Engineering
Editorial Boards, J. Molecular Catalysis B (1995-2001), Chemistry & Biology (2004-), Protein
Engineering (1994-2003), Protein Engineering, Design, and Selection(2003-), ChemBioChem
(2001-)
Member, Board of Directors, Exogene Corporation, 1988-1994
Consulting has included: Eli Lilly, Roche Diagnostics, Life Technologies, Degussa AG
Procter & Gamble, Dow Chemical, British Petroleum, Recombinant Biocatalysis (now Diversa
Corp.), Thermogen, Bayer AG, logen, Maxygen, Fluidigm, Cleary Gottlieb Steen & Hamilton,
Promega, CSL Ltd., Schlumberger, Darby & Darby, Pfizer, BioMarin

Professional Societies

Institute of Medicine of the National Academies
National Academy of Engineering
American Chemical Society
American Institute of Chemical Engineers
Protein Society
American Association for the Advancement of Science
American Society for Microbiology
Fellow, American Institute for Medical and Biological Engineering

Foreign Languages

Italian, Spanish; working knowledge of French, Portuguese

Courses Taught (California Institute of Technology)

Introduction to Biological Design (BE 200b)
Chemical Engineering Separations (ChE 104)
Fundamentals of Biochemical Engineering (ChE 163)
Protein Technology (ChE 176)
Chemical Reaction Engineering (ChE 101)
Chemical Engineering Laboratory (ChE 126a)
Introduction to Chemical Engineering (Laboratory) (ChE 10)
Introductory Chemical Reaction Engineering (ChE 64)

Peer-reviewed publications

1. "An Analysis of Open-Cycle Cooling Systems and Materials," R. K. Collier, R. Barlow, and F. H. Arnold, *J. Solar Energy Eng.* **104**, 28 (1982).
2. "A Note on Liquid Chromatography Plate Height Equations," F. H. Arnold, H. W. Blanch, and C. R. Wilke, *J. Chromatography* **330**, 159 (1985).
3. "Analysis of Affinity Separations I. Predicting the Performance of Large-Scale Separations," F. H. Arnold, H. W. Blanch, and C. R. Wilke, *Chem. Eng. J.* **230**, B1 (1985).
4. "Analysis of Affinity Separations II. The Characterization of Affinity Packings by Pulse Techniques," F. H. Arnold, H. W. Blanch, and C. R. Wilke, *Chem. Eng. J.* **230**, B25 (1985).
5. "Analytical Affinity Chromatography I. Local Equilibrium Theory and the Measurement of Association and Inhibition Constants," F. H. Arnold, S. A. Schofield, and H. W. Blanch, *J. Chromatography* **355**, 1 (1986).
6. "Analytical Affinity Chromatography II. Rate Theory and the Measurement of Biological Binding Kinetics," F. H. Arnold and H. W. Blanch, *J. Chromatography* **355**, 13 (1986).
7. "Structure, Dynamics and Thermodynamics of Mismatched DNA Oligonucleotide Duplexes d(CCCAGGG)₂ and d(CCCTGGG)₂," F. H. Arnold, S. Wolk, P. Cruz, and I. Tinoco, Jr., *Biochemistry* **26**, 4068 (1987).
8. "Protein Design for Nonaqueous Solvents," F. H. Arnold, *Protein Engineering* **2**, 21-25 (1988).
9. "NMR Studies of Crambin Structure and Unfolding in Nonaqueous Solvents," F. H. Arnold, *Ann. N. Y. Acad. Sci.* **542**, 30-36 (1988).
10. "Nuclear Magnetic Relaxation Study of Hindered Rotational Diffusion in Gels," I. L. Claeys and F. H. Arnold, *AIChE Journal* **35**, 335-338 (1989).
11. "Metal Affinity Precipitation of Proteins," M. E. Van Dam, G. E. Wuenschell and F. H. Arnold, *Biotechnol. Appl. Biochem.* **11**, 492-502 (1989).
12. "Aqueous Two-Phase Metal Affinity Extraction of Heme Proteins," G. E. Wuenschell, E. Naranjo and F. H. Arnold, *Bioprocess Eng.* **5**, 199-202 (1990).
13. "A Mathematical Model for Metal Affinity Partitioning," S.-S. Suh and F. H. Arnold, *Biotechnol. Bioeng.* **35**, 682-690 (1990).
14. "Metal Affinity Extraction of Human Hemoglobin in an Aqueous Polyethylene Glycol-Sodium Sulfate Two-Phase System," S. D. Plunkett and F. H. Arnold, *Biotechnology Techniques* **4**, 45-48 (1990).
15. "Characterization of His-X₃-His Sites in α -Helices of Synthetic Metal-Binding Bovine Somatotropin," S. S. Suh, B. L. Haymore and F. H. Arnold, *Protein Engineering* **4**, 301-305 (1991).
16. "Cu(II)-Binding Properties of a Synthetic Metal-Binding Cytochrome c: His-X₃-His in an α -Helix," R. Todd, M. Van Dam, D. Casimiro, B. L. Haymore and F. H. Arnold, *Proteins: Struct. Funct. Genet.* **10**, 156-161 (1991).
17. "Chiral Copper Chelate Complexes Alter Selectivities in Metal Affinity Protein Partitioning," G. E. Wuenschell, E. Wen, R. Todd, D. Shnek and F. H. Arnold, *J. Chromatography* **543**, 345-354 (1991).

18. "Enzyme Engineering for Nonaqueous Solvents II. Additive Effects of Mutations on the Stability and Activity of *Subtilisin E* in Polar Organic Media," K. Chen, A. C. Robinson, M. Van Dam, P. Martinez, C. Economou and F. H. Arnold, *Biotechnol. Progr.* **7**, 125-129 (1991).
19. "Engineered Metal-Binding Proteins: Purification to Protein Folding," F. H. Arnold and B. L. Haymore, *Science* **252**, 1796-1797 (1991).
20. "Surface Charge Substitutions Increase the Stability of α -lytic Protease in Organic Solvents," P. Martinez and F. H. Arnold, *J. Am. Chem. Soc.* **113**, 6336-6337 (1991).
21. "Enzyme Engineering for Nonaqueous Solvents: Random Mutagenesis to Enhance Activity of Subtilisin E in Polar Organic Media," K. Chen and F. H. Arnold, *Bio/Technology* **9**, 1073-1077 (1991).
22. "Template-Mediated Synthesis of Metal-Complexing Polymers for Molecular Recognition," P. K. Dhal and F. H. Arnold, *J. Am. Chem. Soc.* **113**, 7417-7418 (1991).
23. "Metal-Affinity Partitioning of Phosphoproteins in PEG/Dextran Two-Phase Systems," B. H. Chung and F. H. Arnold, *Biotechnol. Lett.* **13**, 615-620 (1991).
24. "Protein Stabilization by Engineered Metal Chelation," J. Kellis, Jr., R. J. Todd and F. H. Arnold, *Bio/Technology* **9**, 994-995 (1991).
25. "Stabilization of Subtilisin E in Organic Solvents by Site-Directed Mutagenesis," P. Martinez, M. E. Van Dam, A. C. Robinson, K. Chen and F. H. Arnold, *Biotechnol. Bioeng.* **39**, 141-147 (1992).
26. "Random Mutagenesis to Enhance Enzyme Activity in Organic Solvents: Characterization of Q103R Subtilisin E," C. Economou, K. Chen and F. H. Arnold, *Biotechnol. Bioeng.* **39**, 658-662 (1992).
27. "Metal-Coordination Interactions in the Template-Mediated Synthesis of Substrate-Selective Polymers: Recognition of Bis(imidazole) Substrates by Cu(II)-Complexing Polymers," P. K. Dhal and F. H. Arnold, *Macromolecules* **25**, 7051-7059 (1992).
28. "Metal-Affinity Electrophoresis of Histidine-Containing Proteins," L. D. Holmes, A. A. Serag, S. D. Plunkett, R. J. Todd and F. H. Arnold, *Methods* **4**, 103-108 (1992).
29. "Tuning the Activity of an Enzyme for Unusual Environments: Sequential Random Mutagenesis of Subtilisin E for Catalysis in Dimethylformamide," K. Chen and F. H. Arnold, *Proc. Natl. Acad. Sci. USA* **90**, 5618-5622 (1993).
30. "Selective Recognition of Bis-Imidazoles by Complementary Bis-Metal Ion Complexes," S. Mallik, R. D. Johnson, and F. H. Arnold, *J. Am. Chem. Soc.* **115**, 2518-2520 (1993).
31. "Ruthenium-Mediated Protein Cross-Linking and Stabilization," A. Muheim, R. J. Todd, D. R. Casimiro, H. R. Gray and F. H. Arnold, *J. Am. Chem. Soc.*, **115**, 5312-5313 (1993).
32. "Towards Materials for the Specific Recognition and Separation of Proteins," S. Mallik, S. D. Plunkett, P. K. Dhal, R. D. Johnson, D. Pack, D. Shnek and F. H. Arnold, *New J. Chem.* **18**, 299-304 (1994).
33. "Multiple-site Binding Interactions in Metal-Affinity Chromatography. I. Equilibrium Binding of Engineered Histidine-Containing Cytochromes c," R. J. Todd, R. D. Johnson and F. H. Arnold, *J. Chromatography* **662**, 13-26 (1994).
34. "Intramolecular Electron Transfer to Chelated Ruthenium Complexes on Cytochrome c," D. R. Casimiro, A. Muheim, J. H. Richards, F. H. Arnold, J. R. Winkler, H. B. Gray, *J. Inorg. Biochem.* **51**, 232 (1993).

35. "Specific Protein Attachment to Artificial Membranes via Coordination to Lipid-bound Copper(II)," D. Shnek, D. Pack, D. Sasaki and F. H. Arnold, *Langmuir*, **10**, 2382-2388 (1994).
36. "Template Polymerization using Metal Ion Coordination: Metal Replacement to Optimize Templating and Substrate Re-Binding" F. H. Arnold, S. Plunkett, V. Sundaresan, *Polymer Preprints* **35**, 996-997 (1994).
37. "Synthetic Bis-Metal Ion Receptors for Bis-Imidazole 'Protein Analogs'," S. Mallik, R. D. Johnson, and F. H. Arnold, *J. Am. Chem. Soc.* **116** (20), 8902-8911 (1994).
38. "Surface Grafting of Functional Polymers to Macroporous Poly(Trimethylolpropane Trimethacrylate)," P. K. Dhal, S. Vidyasankar and F. H. Arnold, *Chemistry of Materials* **7**, 154-162 (1995).
39. "Surface Modification with Molecularly-Imprinted Polymers for Selective Recognition," F. H. Arnold, S. Plunkett, P. K. Dhal and V. Sundaresan, *Polymer Preprints* **36**, 97-98 (1995).
40. "The Temkin Isotherm Describes Heterogeneous Protein Adsorption," R. D. Johnson and F. H. Arnold, *Biochim. Biophys. Acta.* **1247**, 293-297 (1995).
41. "Metal-Induced Dispersion of Lipid Aggregates: A Simple, Selective and Sensitive Fluorescent Metal Ion Sensor," D. Y. Sasaki, D. R. Shnek, D. W. Pack and F. H. Arnold, *Angew. Chem. Intl. Ed. Engl.* **34**, 905-907 (1995).
42. "Molecularly-Imprinted Polymers on Silica: Selective Supports for High Performance Ligand-Exchange Chromatography," S. Plunkett and F. H. Arnold, *J. Chromatography A* **708**, 19-29 (1995).
43. "Engineering Protein-Lipid Interactions: Targeting of Histidine-Tagged Proteins to Metal-Chelating Lipid Monolayers," K. Ng, D. W. Pack, D. Y. Sasaki, and F. H. Arnold, *Langmuir* **11**, 4048-4055 (1995).
44. "Multipoint Binding in Metal Affinity Chromatography II. Effect of pH and Imidazole on Chromatographic Retention of Engineered Histidine-Containing Cytochromes c," R. D. Johnson, R. J. Todd and F. H. Arnold, *J. Chromatography A* **725**, 225-235 (1996).
45. "Surface Site Heterogeneity and Lateral Interactions in Multipoint Protein Adsorption," R. D. Johnson, Z.-G. Wang and F. H. Arnold, *J. Phys. Chem.* **100**, 5134-5139 (1996).
46. "Directed Evolution of Subtilisin E in *Bacillus Subtilis* to Enhance Total Activity in Aqueous Dimethylformamide," L. You and F. H. Arnold, *Protein Engineering* **9**, 77-83 (1996).
47. "Substrate Selectivity of Molecularly Imprinted Polymers Incorporating a Rigid Chelating Monomer, Bis-Methacrylate-(4-methyl, 4'-vinyl)2,2'-bipyridine Cu(II)," P. K. Dhal and F. H. Arnold, *New J. Chemistry* **20**, 695-698 (1996).
48. "Two-Dimensional Protein Crystallization Via Metal-Ion Coordination by Naturally Occurring Surface Histidines," W. Frey, W. R. Schief, Jr., D. W. Pack, C.-T. Chen, A. Chilkoti, P. Stayton, V. Vogel, and F. H. Arnold, *Proc. Natl. Acad. Sci. USA* **93**, 4937-4941, 1996.
49. "Directed Evolution of a para-Nitrobenzyl Esterase for Aqueous-Organic Solvents," J. Moore and F. H. Arnold, *Nature Biotechnology* **14**, 458-467 (1996).
50. "Fluorescent Signaling of Ligand Binding and Assembly In Metal-Chelating Lipid Membranes," K. Maloney, D. R. Shnek, D. Y. Sasaki and F. H. Arnold, *Chemistry & Biology* **3**, 185-192 (1996).
51. "Polymeric Sensor Materials for Glucose," C.-T. Chen, G. Chen, Z. Guan, D. Lee and F. H. Arnold, *Polymer Preprints* **37**, 217-217 (1996).

52. "A Glucose-Sensing Polymer," G. Chen, Z. Guan, C.-T. Chen, V. Sundaresan, L. Fu and F. H. Arnold, *Nature Biotechnology* **15**, 354-357 (1997).
53. "Langmuir Monolayer Characterization of Metal Chelating Lipids for Protein Targeting to Membranes," D. W. Pack and F. H. Arnold, *Chemistry & Physics of Lipids* **86**, 135-152 (1997).
54. "A Metal Chelating Lipid for 2D Protein Crystallization via Coordination of Surface Histidines," D. W. Pack, G. Chen, K. Maloney, C.-T. Chen and F. H. Arnold, *J. Am. Chem. Soc.* **119**, 2479-2487 (1997).
55. "A Glucose-Sensing Polymer," G. Chen, V. Sundaresan and F. H. Arnold, *Proceedings of the ACS Division of Polymeric Materials: Science and Engineering*, Vol. 76, 378-379 (1997).
56. "Optimization of DNA Shuffling for High Fidelity Recombination," H. Zhao and F. H. Arnold, *Nucleic Acids Research* **25**, 1307-1308 (1997).
57. "Functional and Non-functional Mutations Distinguished by Random Recombination of Homologous genes," H. Zhao and F. H. Arnold, *Proc. Natl. Acad. Sci. USA* **94**, 7997-8000 (1997).
58. "Molecularly Imprinted Ligand Exchange Adsorbents for Chiral Separations of Underivatized Amino acids," V. Sundaresan, M. Ru and F. H. Arnold, *J. Chromatography* **775**, 51-63 (1997).
59. "Ligand-Induced Reorganization and Assembly in Synthetic Lipid Membranes," D. W. Pack, K. Ng., K. M. Maloney, F. H. Arnold. *Supramolecular Science* **4**, 3-10 (1997).
60. "Strategies for the *in vitro* Evolution of Protein Function: Enzyme Evolution by Random Recombination of Improved Sequences," J. C. Moore, H.-M. Jin, O. Kuchner and F. H. Arnold, *J. Molecular Biology* **272**, 336-347 (1997).
61. "Random Priming *in vitro* Recombination: an Effective Tool for Directed Evolution," Z. Shao, H. Zhao, L. Giver and F. H. Arnold, *Nucleic Acids Research* **26**, 681-683 (1998).
62. "Design by Directed Evolution," F. H. Arnold, *Acct. Chem. Research* **31**, 125-131 (1998).
63. "Molecular Evolution by Staggered Extension Process (StEP) *in vitro* Recombination," H. Zhao, L. Giver, Z. Shao, J. A. Affholter, F. H. Arnold, *Nature Biotechnology* **16**, 258-262 (1998).
64. "Binding and Two-dimensional Crystallization of Streptavidin at the Air-water Interface via Engineered Cu-IDA Chelator Lipids," K. M. Maloney, W. R. Schief, Jr., F. H. Arnold and V. Vogel, *Coord. Chem. Reviews* **183**, 3-18 (1999).
65. "Laboratory Evolution of a Thermostable Esterase," L. Giver, A. Gershenson, P.-O. Freskgard, F. H. Arnold, *Proc. Natl. Acad. Sci. USA* **95**, 12809-12813 (1998).
66. "Directed Evolution Converts Subtilisin E into a Functional Equivalent of Thermitase, H. Zhao and F. H. Arnold, *Protein Engineering* **12**, 47-53 (1999).
67. "Laboratory Evolution of Peroxide-Mediated Cytochrome P450 Hydroxylation," H. Joo, Z. Lin and F. H. Arnold, *Nature* **399**, 670-673 (1999).
68. "A High Throughput Digital Imaging Screen for the Discovery and Directed Evolution of Oxygenases," H. Joo, A. Arisawa, Z. Lin and F. H. Arnold, *Chemistry & Biology* **6**, 699-706 (1999).
69. "A Structural View of Evolutionary Divergence," B. Spiller, A. Gershenson, F. H. Arnold, R. C. Stevens, *Proc. Natl. Acad. Sci. USA* **96**, 12305-12310 (1999).
70. "Recombination by *in vitro* Heteroduplex Formation and *in vivo* Repair," A. A. Volkov, Z. Shao and F. H. Arnold, *Nucleic Acids Research* **27**, e18 (1999).

71. "A Microfabricated Fluorescence-Activated Cell Sorter," A. Y. Fu, C. Spence, A. Scherer, F. H. Arnold, S. Quake, *Nature Biotechnology* **17**, 1109-1111 (1999).
72. "Exploring Nonnatural Evolutionary Pathways by Saturation Mutagenesis: Rapid Improvement of Protein Function," K. Miyazaki and F. H. Arnold, *J. Molecular Evolution* **49**, 716-720 (1999).
73. "A Membrane-Moderated, Conductimetric Sensor for the Detection and Measurement of Specific Organic Solutes in Aqueous Solutions," F. H. Arnold, W. Zheng and A. S. Michaels, *J. Membrane Sci.* **167/2**, 227-239 (2000).
74. "Inverting Enantioselectivity by Directed Evolution of Hydantoinase for Improved Production of L-Methionine," O. May, P. T. Nguyen, F. H. Arnold, *Nature Biotechnology* **18**, 317-320 (2000).
75. "Methods for in vitro DNA Recombination and Chimeragenesis," A. A. Volkov and F. H. Arnold, *Methods in Enzymology*, Vol. 328 Part C, p. 447-456 (2000).
76. "Random Chimeragenesis by Heteroduplex Recombination," A. A. Volkov, Z. Shao and F. H. Arnold, *Methods in Enzymology*, Vol. 328, Part C, p. 456-463 (2000).
77. "Tryptophan Phosphorescence Study of Enzyme Flexibility and Unfolding in Laboratory-Evolved Thermostable Esterases," A. Gershenson, A., J. A. Schauerte, L. Giver, F. H. Arnold, *Biochemistry* **39**, 4658-4665 (2000).
78. "Formation of Indigo by Recombinant Mammalian Cytochrome P450," E. M. J. Gillam, A. A. Aguinaldo, L. M. Notley, D. Kim, R. G. Mundkowski, A. A. Volkov, F. H. Arnold, P. Souček, J. J. DeVoss, F. P. Guengerich, *Biochem. Biophys. Res. Comm.* **265**, 469-472 (1999).
79. "Directed Evolution Study of Temperature Adaptation in a Psychrophilic Enzyme," K. Miyazaki, P. Wintrode, R. Grayling, D. Rubingh and F. H. Arnold, *J. Molecular Biology* **297**, 1015-1026 (2000).
80. "Functional Expression of Horseradish Peroxidase in *Saccharomyces cerevisiae* and *Pichia pastoris*," B. Morawski, Z. Lin, P. Cirino, H. Joo, G. Bandara and F. H. Arnold, *Protein Engineering* **13**, 377-384 (2000).
81. "Molecular Breeding of Carotenoid Biosynthetic Pathways," C. Schmidt-Dannert, D. Umeno and F. H. Arnold, *Nature Biotechnology* **18**, 750-753 (2000).
82. "Cold Adaptation of a Mesophilic Enzyme by in vitro Evolution," P. L. Wintrode, K. Miyazaki and F. H. Arnold, *J. Biological Chemistry* **275**, 31635-31640 (2000).
83. "Computational Method to Reduce the Search Space for Directed Protein Evolution," C. A. Voigt, S. L. Mayo, F. H. Arnold and Z.-G. Wang, *Proc. Natl. Acad. Sci. USA* **98**, 3778-3783 (2001).
84. "Libraries of Hybrid Proteins from Distantly-Related Sequences," V. Sieber, C. Martinez and F. H. Arnold, *Nature Biotechnology* **19**, 456-460 (2001).
85. "Cost-effective Whole-Cell Assay for Laboratory Evolution of Hydroxylases in *E. coli*," U. Schwaneberg, C. Otey, E. Farinas, P. Cirino and F. H. Arnold, *J. Biomolecular Screening* **6**, 111-117 (2001).
86. "A Versatile High-throughput Screen for Dioxygenase Activity using Solid-Phase Digital Imaging," J. M. Joern, T. Sakamoto, A. Arisawa and F. H. Arnold, *J. Biomolecular Screening* **6** (4) 219-223 (2001).
87. "Directed Evolution of a Cytochrome P450 Monooxygenase for Alkane Oxidation," E. Farinas, U. Schwaneberg, A. Glieder and F. H. Arnold, *Adv. Synth. Catal.* **343**, 601-606 (2001).
88. "Dynamic Pattern Formation in a Microfluidic Device," T. Thorsen, R. W. Roberts, F. H. Arnold and S. R. Quake, *Phys. Rev. Lett.* **86**, 4163-4166 (2001).

89. "Expression and Stabilization of Galactose Oxidase in *Escherichia coli* by Directed Evolution," L. Sun, I. Petrounia, M. Yagasaki, F. H. Arnold, *Protein Engineering* **14**, 699-704 (2001).
90. "Laboratory Evolution of Toluene Dioxygenase to Accept 4-Picoline," T. Sakamoto, J. Joern, A. Arisawa, F. H. Arnold, *Appl. Environ. Microbiol.* **67**, 3882-3887 (2001).
91. "A Colorimetric Assay to Quantify Dehydrogenase Activity in Crude Cell Lysates," K. M. Mayer and F. H. Arnold, *J. Biomol. Screening* **7**, 135-140 (2002).
92. "Analysis of Shuffled Gene Libraries," J. M. Joern, P. Meinhold, F. H. Arnold, *J. Mol. Biol.* **316**, 641-654 (2002).
93. "An Integrated Microfabricated Cell Sorter," A. Y. Fu, H.-P. Chou, C. Spence, F. H. Arnold, S. R. Quake, *Analytical Chemistry* **74**, 2451-2457 (2002).
94. "Protein Building Blocks Preserved by Recombination," C. A. Voigt, C. Martinez, Z.-G. Wang, S. L. Mayo and F. H. Arnold, *Nature Structural Biology* **9**, 553-558 (2002).
95. "Laboratory Evolution of a Soluble, Self-sufficient, Highly Active Alkane Hydroxylase," A. Glieder, E. T. Farinas, F. H. Arnold, *Nature Biotechnology* **20**, 1135-1139 (2002).
96. "Protein Dynamics in a Family of Laboratory-Evolved Thermophilic Enzymes," P. L. Wintrode, D. Zhang, N. Vaidehi, F. H. Arnold, W. A. Goddard III, *J. Mol. Biol.* **327**, 745-757 (2003).
97. "Evolution of the C30 Carotenoid Synthase crtM for Function in a C40 Pathway," D. Umeno, A. V. Tobias, F. H. Arnold, *J. Bacteriology* **184**, 6690-6699 (2002).
98. "Colorimetric Assays for Biodegradation of Polycyclic Aromatic Hydrocarbons by Fungal Laccases," M. Alcalde, T. Bulter, F. H. Arnold, *J. Biomolecular Screening* **7**, 547-553 (2002).
99. "Modification of Galactose Oxidase to Introduce Glucose-6-oxidase Activity," L. Sun, I. Petrounia, M. Alcalde, T. Bulter, F. H. Arnold, *ChemBioChem* **8**, 781-783 (2002).
100. "Regioselectivity and Activity of Cytochrome P450 BM-3 and Mutant F87A in Reactions Driven by Hydrogen Peroxide," P. Cirino and F. H. Arnold, *Adv. Synthesis & Catalysis* **9**, 932-937 (2002).
101. "Functional Expression of a Fungal Laccase in *Saccharomyces cerevisiae* by Directed Evolution," T. Bulter, M. Alcalde, V. Sieber, P. Meinhold, C. Schlachtbauer and F. H. Arnold, *Appl. Env. Microbiol.* **69**, 987-995 (2003).
102. "Directed Evolution of a Genetic Circuit," Y. Yokobayashi, R. Weiss and F. H. Arnold, *Proc. Natl. Acad. Sci. USA* **99**, 16587-16591 (2002).
103. "A C₃₅-Carotenoid Biosynthetic Pathway," D. Umeno and F. H. Arnold, *Appl. Env. Microbiol.* **69**, 3573-3579 (2003).
104. "Elastomeric Microfabricated Fluorescence-Activated Cell Sorters (uFACS)" A. Y. Fu, Y. Yokobayashi, F. H. Arnold, S. R. Quake, in *Flow Cytometry for Biotechnology*, Oxford University Press, L. A. Sklar, Ed., 2003.
105. "Evolutionary Design of Genetic Circuits and Cell-Cell Communications," Y. Yokobayashi, C. H. Collins, J. R. Leadbetter, R. Weiss, F. H. Arnold, *Adv. Complex Systems* **6**, 37-45 (2003).
106. "Global Incorporation of Norleucine in Place of Methionine in Cytochrome P450 BM-3 Heme Domain Increases Peroxygenase Activity," P. C. Cirino, Y. Tang, D. A. Tirrell and F. H. Arnold, *Biotechnology & Bioengineering* **83**, 729-734 (2003).
107. "Library Analysis of SCHEMA-Guided Protein Recombination," M. M. Meyer, J. J. Silberg, C. A.

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